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MINING AND GRINDING METHODS AND COSTS AT THE CLAY CITY PIPE CO. CLAY MINE, UHRICHSVILLE, OHIO

BY

E. J. LINTNER

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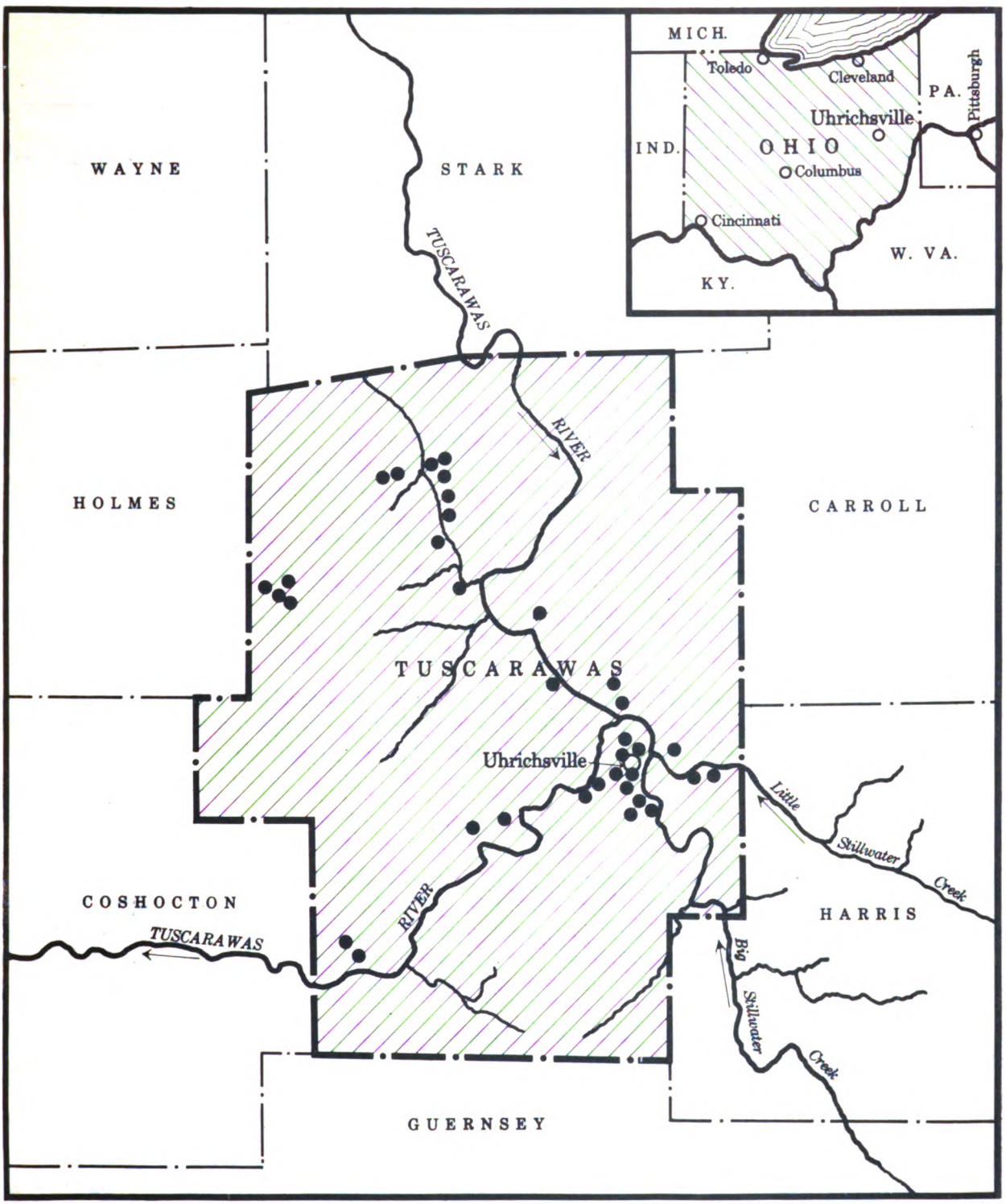

Figure 1.—Location of ceramic plants, Tuscarawas County.

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MINING AND GRINDING METHODS AND COSTS AT THE CLAY CITY PIPE CO. CLAY MINE, UHRICHSVILLE, OHIO[1]

By E.J. Lintner[2]

INTRODUCTION

This paper is one of a series being prepared by the United States Bureau of Mines describing clay mining, crushing, and grinding methods and costs at various operations throughout the United States. These papers are designed to disseminate technical information regarding methods used. The cost tabulations represent local operating expenditures only and not total production costs. Although the publication of total production costs might not be advisable in some instances, yet a knowledge of operating costs is essential to the technical discussion and study of the methods employed. The attention of the reader is specifically called to this differentiation in order that no misunderstanding of the scope of the cost tabulations shall ensue.

The following report deals specifically with the methods employed by the Clay City Pipe Co., Uhrichsville, Tuscarawas County, Ohio.

The author wishes to acknowledge the assistance of the following persons in the preparation of this paper: E.E. Hillyer, vice president and general manager; J.K. Green, plant superintendent; and Wm. Tanzie, mine foreman.

HISTORICAL

The beginning of the sewer pipe industry in this district dates from 1887. In that year the Diamond Fire Clay Co. was organized, and 1 year later the Uhrichsville Fire Clay Co. Other companies were soon formed, mergers took place, and the industry developed rapidly. Soon Tuscarawas County became the leading ceramic locality in the State.

Uhrichsville, in the east-central part of the county, is the center of the ceramic industry, which is scattered along the valley of the Tuscarawas River and its major tributaries, the Little and the Bit Stillwater Creeks. Figure 1 is a location map of this district.

The Clay City Pipe Co. probably is the youngest company operating in the valley at present, having been organized in 1925 by E.E. Hillyer.

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2/ Associate mining engineer, U.S. Bureau of Mines.

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A site was selected and the area carefully drilled to determine the extent and quantity of clay present. The No. 6 coal seam was opened up, and a slope was driven to the Lower Kittanning bed of clay. A large, substantial, brick building was erected nearby to house the manufacturing operations.

The plant is about 3 miles south of Uhrichsville in Big Stillwater Creek Valley. It is served by a branch line of the Baltimore & Ohio Railroad. Excellent highways also permit rapid truck-delivery service to all points.

Capable and efficient management accounts for this company's rapid progress and growth. This company operates one of the four deairing machines, used in the manufacture of sewer pipe, that are found east of the Mississippi River.

GEOLOGY

The Lower Kittanning bed of clay is mined extensively in this area. This bed belongs to the Allegheny formation of the Pennsylvanian system. The thickness of this formation in Ohio ranges from 125 to 250 feet, averaging about 200 feet[3]. There are in all eight beds of clay in this formation, the Lower Kittanning being by far the most important.

This valuable clay bed outcrops across the State and extends from the extreme southern tip of the State in Lawrence County to the Pennsylvania State line in Mahoning County. Although it is mined in virtually every county through which it passes, Tuscarawas County produces by far the largest quantity of clay.

The Lower Kittanning member is composed of a coal seam beneath which are two beds of fireclay. The first bed, directly below the coal seam is an excellent plastic clay, while the bed below this is flint clay. In Tuscarawas County the thickness of the former averages 10 feet. That of the latter will run 4 feet. The overlying coal seam usually averages 2 feet, 6 inches[4].

Besides being the chief clay-bearing formation in Ohio, the Allegheny is the most important coal-bearing formation also. Consequently, coal, an important factor in the heavy ceramic industry, is near at hand. About 30 feet above the Lower Kittanning clay bed lies the well known No. 6 coal seam. This is an excellent grade of fuel and is mined throughout the district.

The surrounding countryside is dotted with rough hills and is traversed in a southwesterly direction by the Tuscarawas River.

PHYSICAL CHARACTERISTICS

The plastic clay found in the Lower Kittanning member ranges in color from light to dark gray. Its texture is very fine, its bonding power is rather high, and it disintegrates readily on weathering.

3/ Stout, Wilbur, Stull, R.T., McCaughey, Wm. J., Demorest, D.J., Coal Formation Clays of Ohio: Geological Survey of Ohio Bull. 26, 1923, p. 243.

4/ Stout, Wilbur, Stull, R.T., McCaughey, Wm. J., Demorest, D.J., Coal Formation Clays of Ohio: Geological Survey of Ohil Bull. 26, 1923, pp. 305-306.

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The flint clay usually is dull gray and is rather dense and hard. This clay also weathers readily and develops sharp edges and corners5/.

In the mine of the Clay City Pipe Co., only the plastic clay is mined. Its thickness is about 7 1/2 feet while that of the overlying coal seam is 2 feet 4 inches.

METHODS OF PROSPECTING AND EXPLORATION

In drilling the property, six holes were put down with a churn drill. These holes were spaced about 1,000 feet apart over approximately 20 acres. No samples were taken for chemical analysis. The log of a typical borehole is as follows:

Strata	Feet
Surface	10.0
Shale rock	8.0
Red clay	6.0
Shale rock	26.0
No. 1 clay	10.0
Sandstone	30.0
Shale	5.0
Coal	1.0
Clay	9.0
Sandstone	10.0
Shale	19.5
No. 6 coal A	0.5
Clay	5.0
Sandstone	60.0
Shale	1.5
No. 6 coal	3.0
Clay	9.5
Sandstone	6.0
Shale	12.5
No. 5 coal	1.5
Fire clay	15.0
	249.0

METHODS OF SAMPLING AND ESTIMATION OF TONNAGES AND VALUES

The manufacture of heavy ceramic wares does not require frequent sampling and testing of the raw clay. Especially is this true when a bed of clay is as uniform as the Lower Kittanning.

5/ Stout, Wilbur, Stull, R. T., McCaughey, Wm. J., Demorest, D.J., Coal-Formation Clays of Ohio: Geological Survey of Ohio Bull. 26, 1923, p. 272.

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METHODS OF DEVELOPMENT AND MINING

Throughout this area the Lower Kittanning member is generally found above drainage. Universal practice in this field is to sink a slope, ranging from 10 to 25 percent downgrade into the clay bed. Either a single- or a double-entry room-and-pillar system of mining is then employed.

The slope of the Clay City Pipe Co. mine is approximately 15 percent and is 260 feet long from mouth to foot. Throughout its length, three-piece square-cut oak-timber sets are placed on 4-foot centers and lagged with 2- by 10-inch oak. The posts and caps are 8- by 8-inch timber. Figure 2a illustrates the method of timbering used.

Entries are driven 12 feet wide, and the rooms are 14 to 16 feet wide. The latter are driven on 100-foot centers. Crosscuts 16 feet wide usually are driven every 100 feet, so that good substantial pillars approximately 85 feet square are left for support. After mining has reached the property line the pillars are drawn. (See fig. 3, cross-hatched area.)

The seam of coal directly over the clay bed is of such poor quality that it has been left in place. Above this coal lies a bed of rather poor shale. This requires that a considerable amount of timbering be employed for support of the roof. The timbering methods employed will be described later in this paper.

Thirty feet above the clay bed lies the No. 6 coal seam, which is reached by a rather flat slope not far from the mine entrance. Here, again, the room-and-pillar system of mining is used. Twenty-one men are employed and produce 60 tons of coal per day, an amount sufficient to satisfy present plant requirements. The mine will produce approximately 110 tons of clay per 8-hour day with a crew of 10 men and one foreman underground.

The accompaning map (fig. 3) shows the clay and coal mines, the clay mine being readily distinguishable by its large pillars.

MINING METHODS

Drilling

Two drillers working together do all the necessary drilling. Each man operates a mounted hand auger drill having solid feed bar 36 inches long, and 1-1/8 inches in diameter, with 6 threads per inch. It is rotated by means of a handle or crank. A bronze thread box fitted with lugs supports the drill on a double column and permits the feed bar to advance when rotated. The column is notched so that the drill can be readily adjusted for holes of different height. The fed box is split and hinged so that the entire drill can be quickly set up or taken down.

Two sizes of twisted drill steel are used. In the top holes 2 1/2-inch-diameter drill steel, having 5 turns per foot, is used. In the bottom holes 2-inch-diameter steel having 6 turns per foot is used. The steel is made up in lengths of 2,4,6, and 8 feet with a split fishtail bit on one end and a

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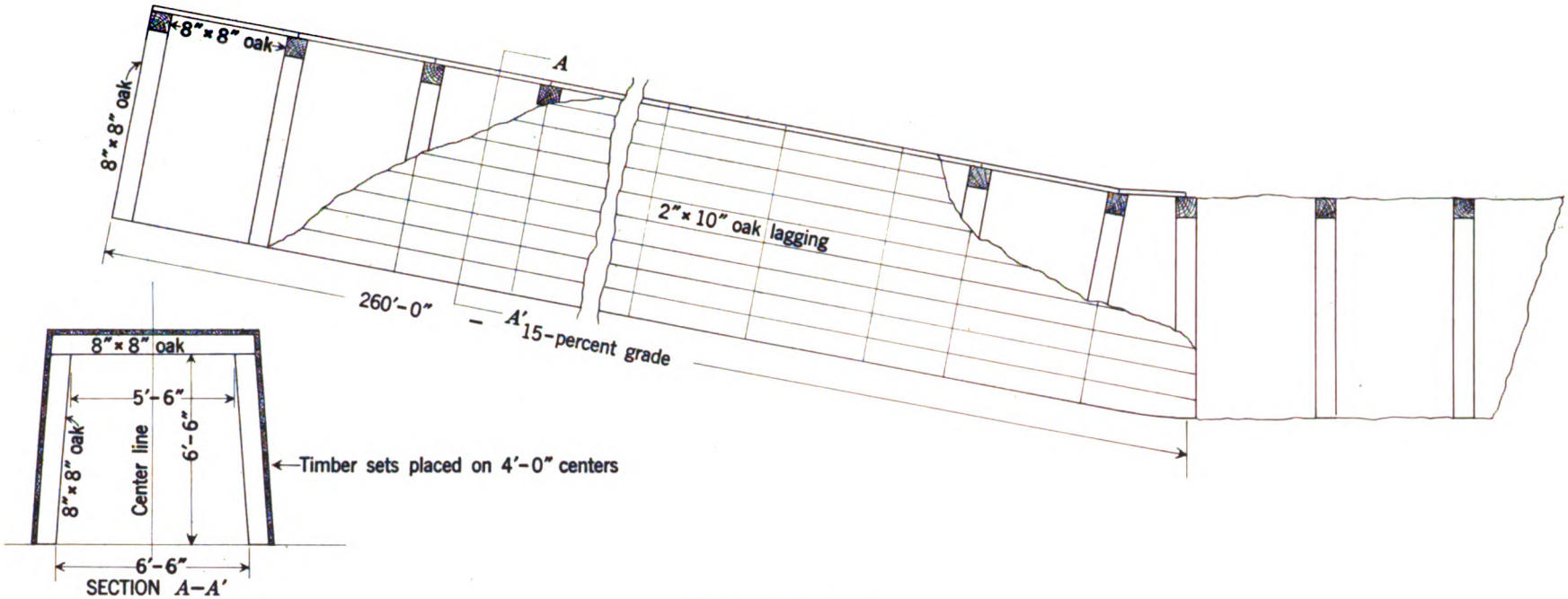

Figure 2a.—Slope timbering.

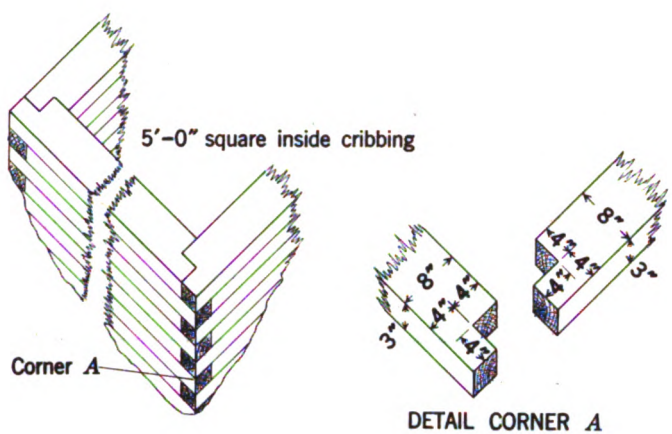

Figure 2b.—Air-shaft cribbing.

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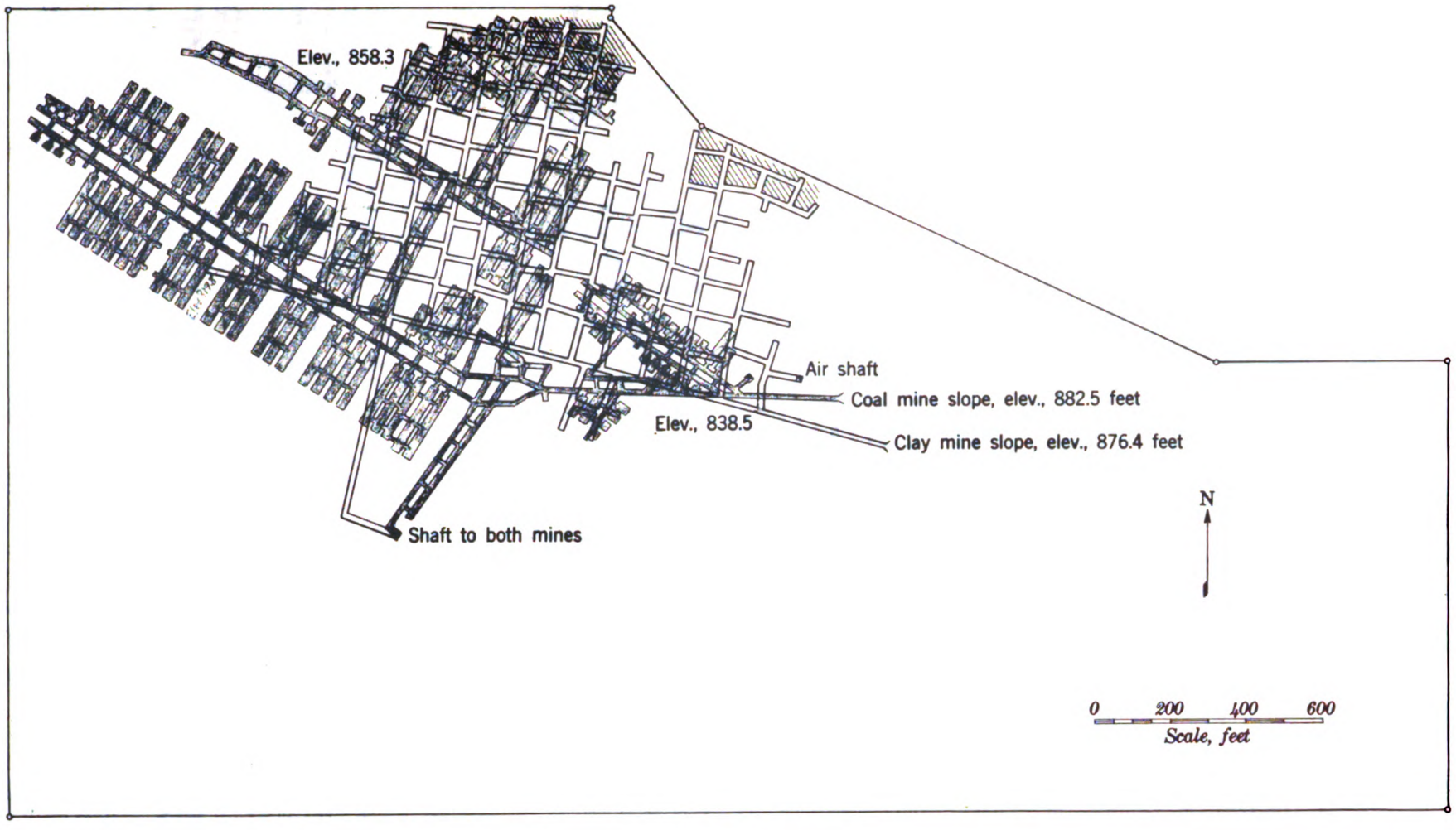

Figure 3.—Mines of Clay City Pipe Co., Tuscarawas County, Ohio.

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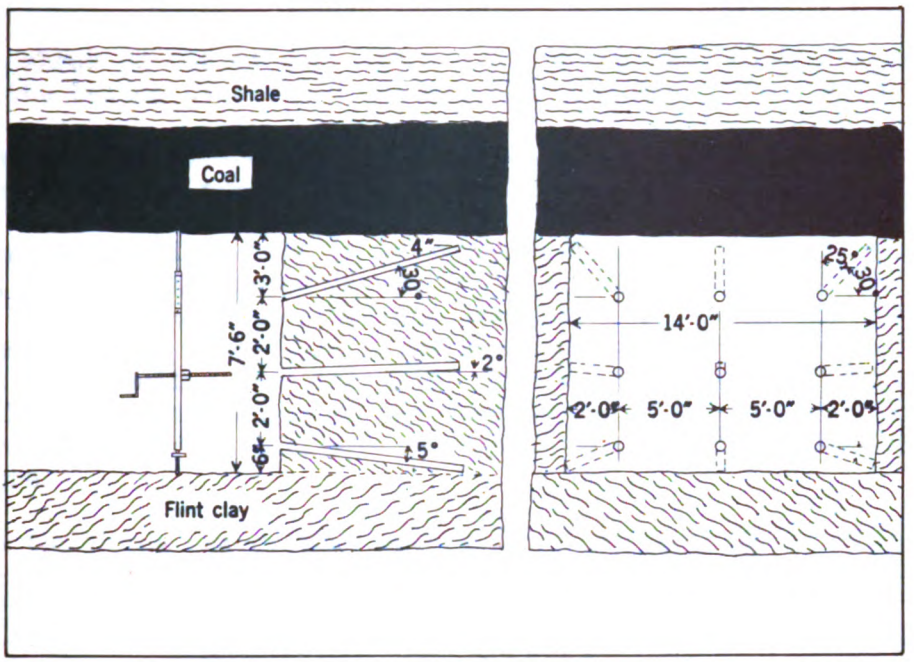

Figure 4.—Drill-hole arrangement.

Wheel diameter,	16 inches
Wheel face,	3 inches
Wheel base,	19 inches
Gage,	36 inches
Axle diameter,	2 inches
Sides, ends,	1½-inch oak
Floor,	2-inch oak

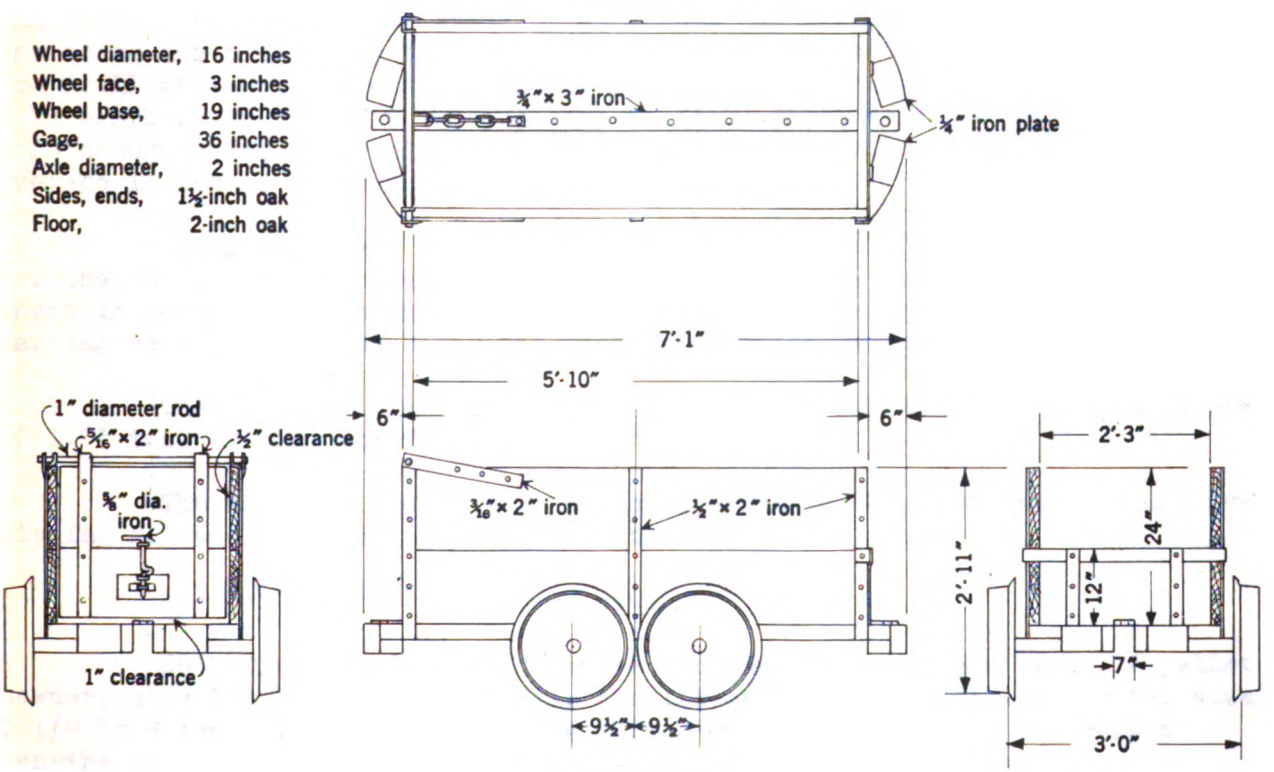

Figure 5.—Mine car.

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flat, tapered shank on the other. The top holes are drilled 2 3/4 inches in diameter and the bottom ones 2 1/4 inches; they average 7 feet in depth.

Each driller erects his drill column about 3 feet from the face behind the point where the row of holes is to be drilled. A small hole is made in the clay face with a pick at the point where the hole is to be started. The 2-foot length of drill steel is inserted in the flat, tapered socket of the feed bar, the machine placed on the drill column, the thread box closed, and drilling begun. After the steel has advanced its full length the feed box is opened, the feed bar moved back or perhaps lifted out of the fed box entirely, and the drill steel pulled from the hole. Now the next piece of drill steel is inserted in the hole, the socket of the feed bar slipped over the shank, the feed bar placed in the feed box, and the latter clamped; the operator then proceeds as before.

The top holes are drilled upward at an angle of 30° from horizontal and collared at a point 3 feet from the roof. The rib holes are drilled at an angle of 25° toward the rib and about 2 feet from the rib line itself. The center holes are drilled upward at an angle of about 2° above the horizontal. The bottom holes are drilled at an angle of 5° below the horizontal and collared at a point about 6 inches above the floor. The top holes will end about 4 inches below the roof while the bottom holes will end in the floor itself. Figure 4 shows the drill-hole arrangement in detail.

The top plastic clay drills very easily. In this material the driller can advance the steel at a speed of 20 inches per minute. The bottom holes approaching the flint clay in the floor are more difficult to drill. Occasionally the drill will hit a piece of silica, when it becomes necessary to start another hole nearby. At times it is necessary to start three or four times before a soft enough point is found. In this material the actual drilling speed will average 11 inches per minute.

Usually two men take about 2 1/2 hours to drill the 9 holes required for one room. Two rooms are drilled per day. The balance of their time is spent in moving and setting up their machines, cleaning out the holes, making tamping cartridges, assembling the necessary explosives, and loading the holes.

The 18 holes drilled per day will produce 123 tons of clay, an average of 1.01 tons of clay per foot of hole drilled.

The drillers are paid at an hourly rate of 62 cents, the company furnishing all tools, steel, explosives, etc.

Blasting

Both black powder and dynamite are used. The former is no. 4 pellet powder, size 1 3/4 x 8 inches, while the latter is no. 2, gel x dynamite, size 1 1/4 by 8 inches. Single-tape safety fuse cut in approximate 8 1/2-foot lengths and no. 6 caps complete the charge.

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The holes are loaded as follows: In the two top rib holes 2 1/2 sticks of pellet powder are placed, with 3 1/2 sticks in the top center hole. In the middle rib holes 2 1/4 sticks of pellet powder are placed, with 2 1/2 sticks in the middle center hole. Gel-x is placed in all the bottom holes, 3 sticks in the rib holes are 4 sticks in the center hole. The detonator is always placed in the next to the last stick of dynamite. Tamping shells 2 1/2 by 14 inches are rolled and filled at the face with the drill cuttings. The rest of the holes are now filled with these tamping shells, flush with the collar of the hole. The numbers on figure 4 indicate their order of firing.

An average shot of nine holes will produce approximately 64 tons of broken clay. This is at the rate of 0.48 pounds of explosive per ton of clay.

All blasting is done by the two drillers at the end of the shift after the other miners have departed.

Loading

Five loaders are required to load the broken clay. Each man works alone, loading the clay into cars of 26 cubic feet capacity. He will average 15 cars per day or, roughly, 24 tons. All the cars are weighed before being dumped into the crusher, the men being paid at a rate of 26 cents per ton. Each loader is required to furnish his own set of tools, such as sledge, pick, and shovel.

Transportation

As the working places are close together, the haulage distance relatively short, and the track bed kept in good condition, only one mule and driver are required to serve the five loaders. He obtains his empties at the foot of the slope and pulls a train of two cars each way. Upon reaching the bottom he couples his loads together into trains of five cars each, attaches the hoist cable, picks up his empties, and returns again inside. The average haul is approximately 1,600 feet one way, with a slight grade against the loads.

The tracks are 36-inch gage. Twenty-pound rails are used on the slope and main entries; 12-pound rails are used on the room turnouts, together with no. 2 frogs, while oak rails 3 inches by 5 inches by 8 feet are used in the rooms. When the oak rails are no longer fit for use as such, they are cut in two and used either as room ties or else to corduroy the main-entry track. These tracks are graded and corduroyed for a considerable distance. The track bed is kept well above the water and consequently is dry and even dusty in places, which is very unusual for a clay mine.

One trackman is well able to take care of all the track laying.

The mine cars (fig. 5) are of solid oak construction, purchased locally. As stated above, they have a capacity of 26 cubic feet. Their weight empty is about 990 pounds, and when a heaping load is placed on them it will average 4,190 pounds gross. There are 17 cars in daily use and usually one undergoing repairs.

The mule is always brought to the surface at the end of each shift and housed in a comfortable barn nearby.

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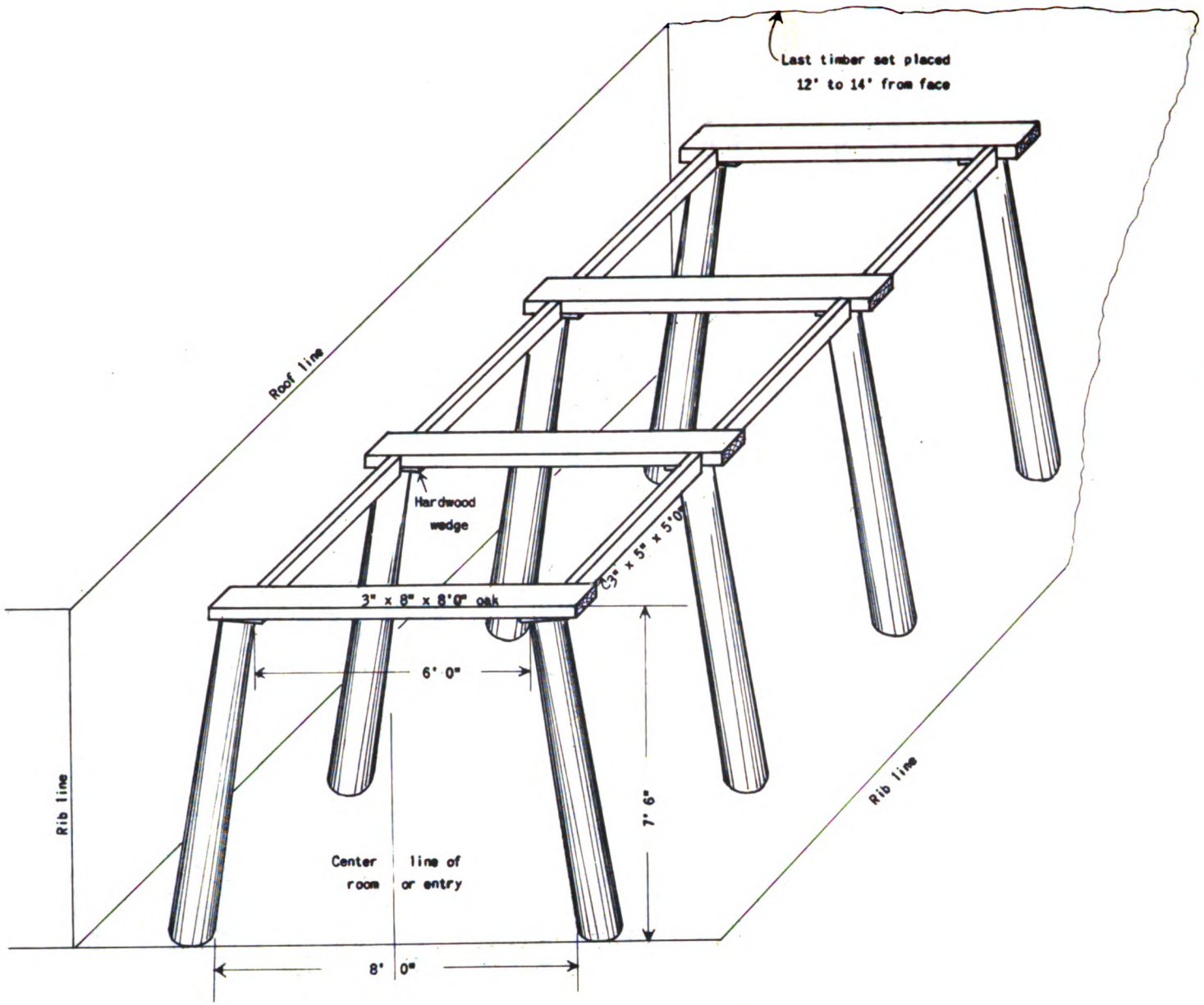

Figure 6.- Method of timbering rooms and entries.

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Timbering

As previously mentioned, considerable timbering is required. Three-piece round timber sets are employed. These are placed 5 feet apart down the center of each entry and room to within 12 or 14 feet of the face. The posts are placed 8 feet apart at the bottom and 6 feet apart at the top and are capped with a 3-inch by 8-inch by 8-foot oak piece. All the timber used is cut locally and ranges from 7 to 9 feet in length and is 7 inches in diameter at the small end. Oak, hickory, maple, and chestnut are used. The lumber costs 5 cents per foot delivered. Figure 6 shows the method employed in room-and-entry timbering.

One man usually is able to do all the timbering. When necessary he calls upon the nearest man available to assist him with his work.

As the mine is only 11 years old, the timbers are in good condition, very little replacement having been found necessary. The amount of timber used during 1935, exclusive of cap pieces, was 0.67 linear foot per ton of clay mined.

Pumping

Proper ditching and handling of the mine water drain it to a large sump alongside the main entry not far from the foot of the slope. From here, it is pumped to the surface through a vertical shaft that also serves the coal mine above for the same purpose. At present a new 2-inch "built-together" motor-pump unit is used to perform this work. This unit consists of a 2-inch centrifugal pump, side suction, and having a bronze impeller, mounted directly on the motor shaft. It is a small compact unit occupying little space. Its rated capacity is 240 g.p.m. The motor driving this unit is 10-horsepower, 220-volt, 24-ampere, 3-phase, 60-cycle, with a speed of 3,450 r.p.m. This unit operates approximately 6 hours daily.

Before this new pump was installed a single-cylinder, 6- by 6-inch geared pump was used. This pump had a rated capacity of 80 g.p.m. and was driven by a 5-horsepower, 220-volt, 14-ampere, 3-phase, 60-cycle motor with a speed of 1,200 r.p.m. This unit formerly operated approximately 9 hours daily. At present it is used very little, being held for standby purposes only. The new pump is well able to handle the regular volume of water encountered.

A third pump is occasionally used to drain a few intermediate points adjacent to the main entry. This is a 1 1/2-inch centrifugal pump driven by a 3-horsepower, 220-volt, 3-phase, 60-cycle motor running at 1,800 r.p.m. It discharges into the large sump above mentioned. The mine foreman operates these pumps in addition to his other duties.

Approximately 30,000,000 gallons of water are handled during an average year, or at the rate of 2,000 gallons per ton of clay mined. Compared with other clay mines in the district this is unusually low. This can be accounted for in two ways - first, the coal bed being worked 30 feet above is kept fairly dry so that very little water seeps through the intervening soft strata into the clay mine; and, second, the clay bed here produces very little water.

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The mine of the Clay City Pipe Co. is an excellent example of what can be accomplished by efficient handling of all underground water. Ordinarily the average clay mine is a mass of water and mud throughout. Here the entries and rooms are dry and, as explained above, even dusty in places. As a result of these better working conditions for the men production is increased, and costs are correspondingly lower.

Ventilation

Approximately 300 feet from the slope entrance is a vertical shaft that serves as the exhaust or return airway. A 36-inch-diameter disk fan traveling at 640 r.p.m. is housed in a small frame building beside the shaft. This fan is driven through a 4-inch by 5 1/2-foot rubber transmission belt by a 3-horsepower, 220-volt, 7.85-ampere, 3-phase, 60-cycle motor traveling at a speed of 1,800 r.p.m. The rated capacity of the fan is 10,000 cubic feet of air per minute. Efficient control of the air current underground provides excellent ventilation throughout. The air shaft is 5 feet square inside the cribbing and is 86 feet deep. It was sunk from the surface and is close-cribbed throughout with 3- by 8-inch oak. Figure 2b shows the method employed in placing the cribbing.

Hoisting

Trains of five cars each are pulled to the surface by means of a single cone-friction drum electric geared hoist. The drum is 18 inches in diameter and 24 inches in length; it travels at a speed of 44 r.p.m. The hoisting speed is 205 feet per minute. A 5/8-inch-diameter, 6- by 19-inch, ordinary-lay, hemp-center, plow-steel cable 1,550 feet long is used. This will make nine complete wraps on the hoist drum when wound and leave two wraps when unwound. Oak idlers 4 inches in diameter and 12 inches in length are spaced 150 feet along the slope. The life of this cable is 12 to 14 months.

A 20-horsepower, 220-volt, 54.4-ampere, 3-phase, 60-cycle motor traveling at 860 r.p.m. drives this hoist through a single-geared reduction shaft.

The average time required to pull a train of five cars from the slope bottom to the crusher floor is 5 1/2 minutes. Upon their arrival here the hoist engineer first sprags the cars and then uncouples the hoist cable. Then he uncouples the first car and pushes it forward to the platform scale for weighing. Next he pushes the car onto the "kick-back" dump (fig. 7) and then returns it to the empty car siding. The "kick-back" dump is 52 inches long and has a 2-inch-diameter shaft 21 inches behind the inside of the curved rail of the horn. A suitable counterweight is placed on an 8-foot arm attached to the floor of the dump. When all five cars have been handled in this manner they are coupled, the hoist cable is attached, and the cars are returned to the bottom of the slope. It usually requires 20 to 25 minutes for one man to handle a round trip of five cars in this manner. Figure 8 shows the track layout in the crusher building.

The track scale is of the double-beam type, with a platform 6 feet long. It is about 15 feet from the dump. The cars will generally average 4,190 pounds gross or 3,200 pounds net. A good heaping load is required, however, to achieve this weight.

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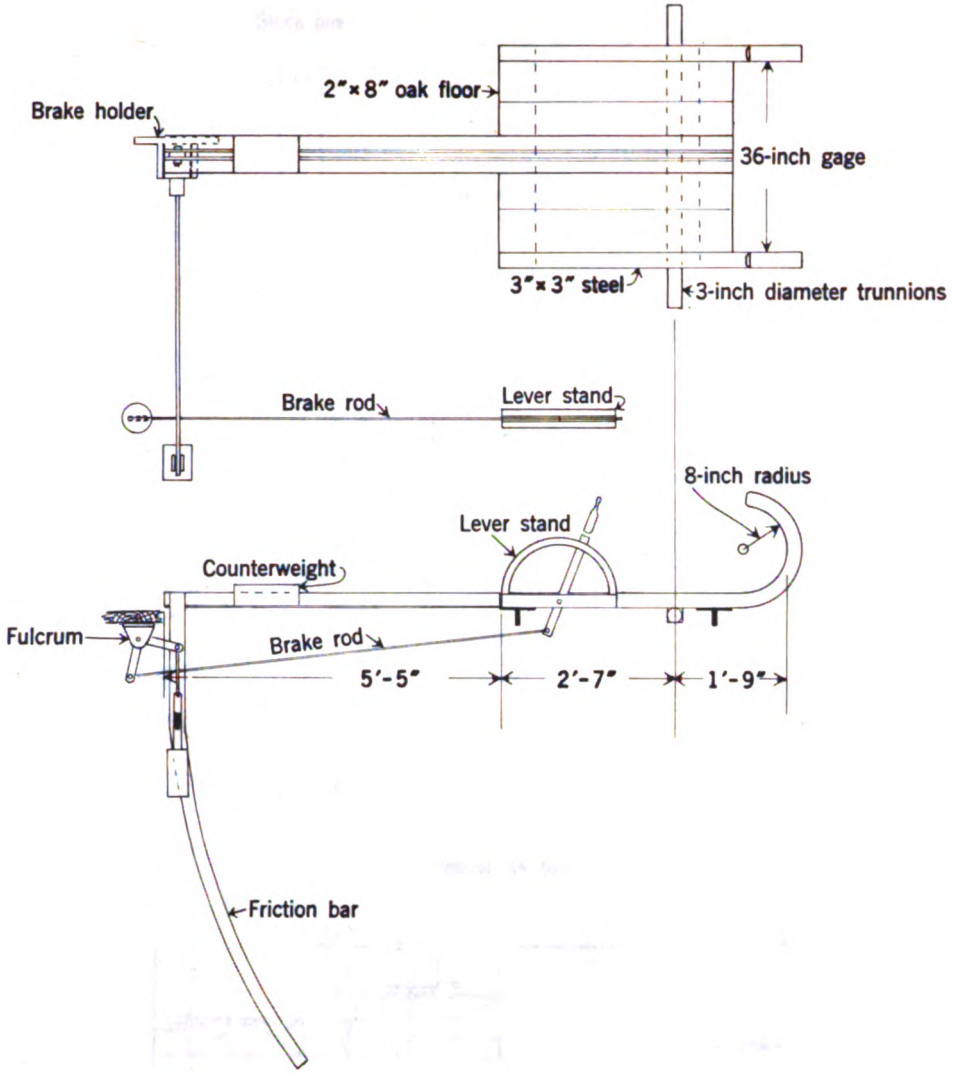

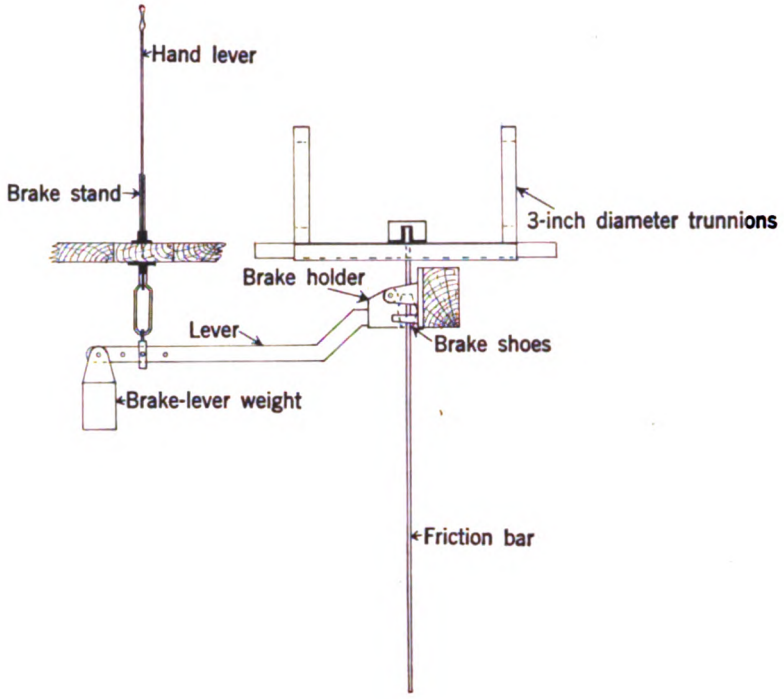

Figure 7.—Kick-back dump.

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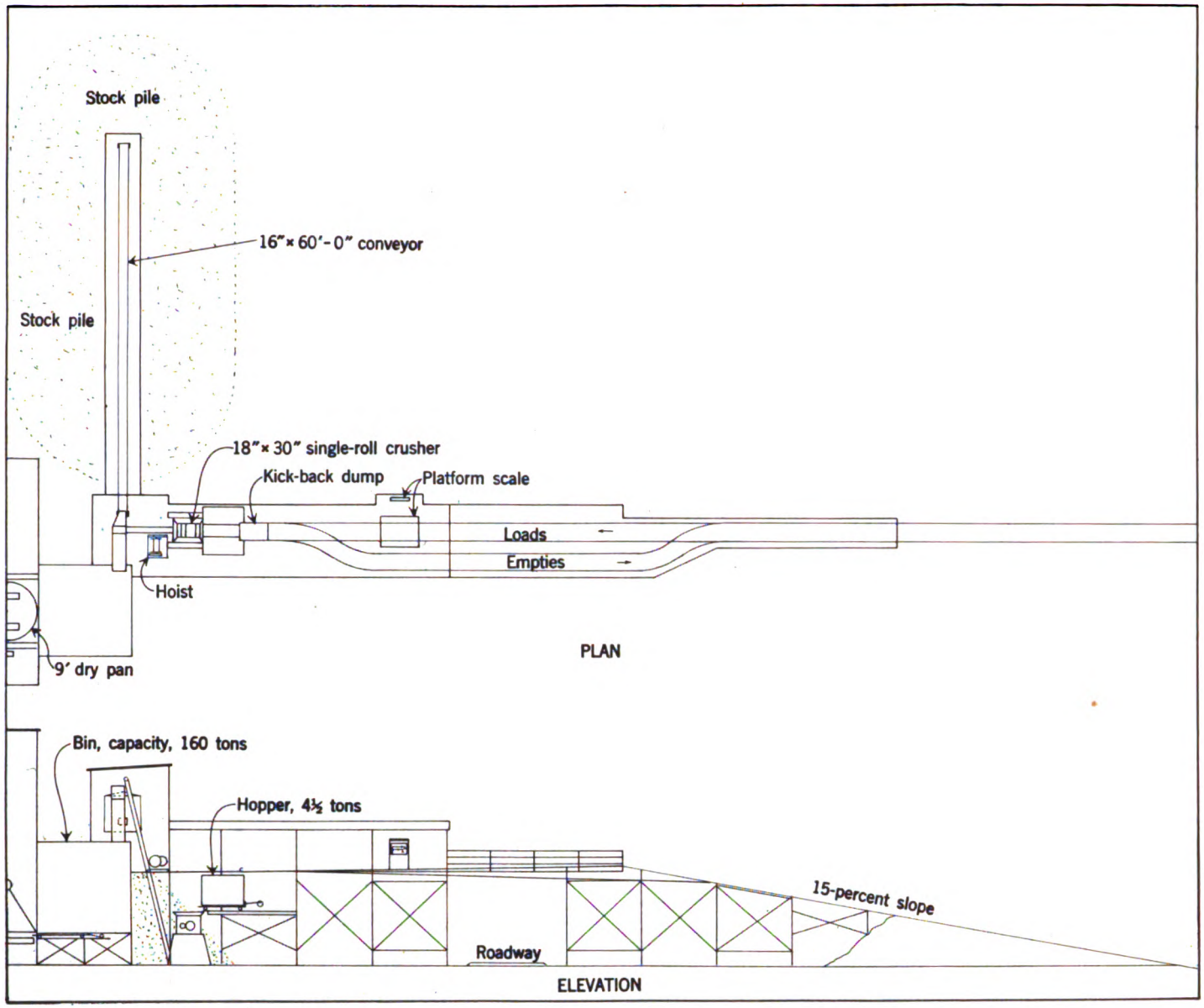

Figure 8.—Tipple storage.

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Pillar Drawing

At present no pillars are being drawn. The cross-hatched area in figure 2, indicates pillars that have been drawn in the past.

MILLING METHODS

Crushing

The mine cars are dumped into a wooden hopper 7 feet long, 8 feet wide, and 5 feet deep in front of the crusher. Its capacity is three cars, or approximately 5 tons of mined clay.

A reciprocating plate feeder feeds this clay into the crusher. The feeder is 7 feet long and 29 inches wide and rolls on four single-flanged wheels 16 inches in diameter, 2 1/2-inch face. The depth of the clay feed is 29 inches. The capacity of this unit at a speed of 17 four-inch strokes per minute is 76 tons per hour. It is driven by an 8-inch by 19 1/2-foot rubber belt off the roll shaft of the crusher.

The crusher has a single roll 18 inches in diameter by 30 inches in length, fitted with 3- by 3-inch teeth or nubs and mounted on a 5 1/2-inch diameter shaft. It runs at 50 r.p.m., and the peripheral speed is 260 feet per minute. The capacity of the crusher at this speed is 60 tons per hour. The maximum size of the product delivered is 6 inches.

A 25-horsepower, 220-volt, 64-ampere, 3-phase, 60-cycle motor traveling at 865 r.p.m. drives this unit through a 10-inch by 15-foot 4-inch rubber transmission belt. This motor is on the main floor of the crusher building about 15 feet to the rear of the mine hoist.

The crushed clay falls upon a short chute and then into an open continuous bucket elevator, whence it is taken to the top of the crusher building. The elevator is of the double-chain type, 32 feet C-C, and inclined at an angle of 75° from the horizontal. The buckets measure 12 by 6 inches. This unit is driven by a 28-inch sprocket whose r.p.m. is 38. Its capacity at a speed of 270 feet per minute is 100 tons per hour. The motor driving this elevator is 15-horsepower, 220-volt, 12-ampere, 3-phase, 60-cycle, traveling at a speed of 860 r.p.m. A 6-inch by 5-foot 10-inch rubber transmission belt completes the drive.

The elevated material can now be sent either to the crushed-clay surge bin or out onto the weathered clay stock pile.

Weathered-Clay Stock Pile

In the latter instance the clay is discharged onto a 20- by 48-inch metal chute pitched at 75° from the horizontal, which, in turn, deposits the clay onto a 16-inch by 60-foot flat horizontal conveyor belt. The area beneath the last 40 feet of this belt serves as the stock pile proper. This belt is driven by a 22-inch pulley traveling at 34 r.p.m. Its capacity, at a speed of 195 linear feet per minute, is 90 tons per hour.

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A 10-horsepower, 220-volt, 27-ampere, 3-phase, 60-cycle motor traveling at 1,140 r.p.m. drives the conveyor through a countershaft drive. The first reduction from the motor has a 6-inch by 10-foot rubber belt, while the final reduction to the headshaft has cut spur gears.

The height of the clay pile beneath this belt is 22 feet. The angle of repose of the crushed clay is 36°. Approximately 1,300 tons of clay can be placed on this pile for weathering. The conveyor belt alone is covered, the clay itself being exposed to the elements.

In reclaiming this clay it is loaded into wheelbarrows, carried into the mill, and dumped directly into the dry pan.

Mill Surge Bin

The crushed clay sent to the mill falls from the crusher elevator upon a 3- by 10-foot metal chute and then drops into the surge bin. This is 14 feet 8 inches long, 15 feet wide, and 15 feet high and is built of 2- by 10-inch lumber placed on end. Its capacity is, roughly, 160 tons of clay. This bin is between the crusher building and the dry-pan room.

The material is drawn from this bin by means of a reciprocating plate feeder 9 feet long by 24 inches wide. It rolls on four single-flanged, 16-inch-diameter, 2 1/2-inch-face wheels. The depth of the material carried forward on the feeder is 20 inches. The capacity of this feeder at a speed of 16 five-inch strokes per minute is 64 tons per hour. It is driven by a 7-inch by 21-foot 5-inch rubber transmission belt off the horizontal shaft of the dry pan into which it feeds.

Grinding

One standard 10-foot dry pan is used for grinding. It consists of a 10-foot-diameter pan mounted on a heavy forged shoulder placed near the lower end of a vertical forged-steel shaft. This shaft is 10 inches in diameter at the bottom and 6 inches at the top. Mullers, 60 inches in diameter and having a 12-inch face, provide the necessary grinding action against the rotating pan. Sectional screen plates having 3/16-inch slots are placed just out-side the path of the mullers. The life of these screen plates is usually 4 months.

The pan itself travels at a speed of 32 r.p.m. Its capacity at this speed is 15 tons per hour.

It is driven by a 17-inch by 17-foot 8-inch rubber transmission belt off the main-line shaft located on the ground floot in the main mill building. a 48-inch-diameter, 18-inch-face friction clutch pulley mounted on the horizontal shaft of the dry pan controls the operation of this unit.

Elevating

The material from the dry pan falls into a vertical wood-enclosed belt elevator 16 inches by 48 feet, whence it is discharged over the screen.

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The buckets on this elevator measure 16 by 6 inches and are spaced 14 inches apart. The elevator runs over an 18-inch-face, 30-inch-diameter pulley traveling at 40 r.p.m. Its capacity at a speed of 312 feet per minute is 250 tons per hour. This elevator is driven through a countershaft off the main-line shaft.

Screening

The finely ground clay is discharged over an electric vibrating screen 3 by 5 feet inclined at an angle of 35° from the horizontal. The opening in the wire screen is 1/16- by 3/8-inch with the longer opening at right angles to the path of flow of material. The approximate size of the product delivered is 10-mesh.

Previous to the installation of this vibrating screen, a perforated metal-plate screen measuring 11 by 6 feet was used. In installing the vibrating screen a 3-foot section of the old screen was cut away at the head for its location. Thus the present screen really consists of the electric vibrating screen, below and attached to which is the metal perforated plate screen 8 feet long and 6 feet wide. The perforated plate section is composed of two plates or sections, one having 3/16-inch and the other 1/8-inch perforations.

Different mesh is employed to secure the proper proportion of the various size clay particles for the particular product to be manufactured. When fine clay is desired, the same small mesh is employed on both sections of the screen. The same thing applies when a coarser product is desired. Intermediate mixtures are obtained by assembling different mesh plates, on the unit. This accounts for the present assembly.

The material passing through this screen falls into a single chute leading into the finished clay storage bin. The material passing over the screen falls into an 8- by 8-inch wood chute, whence it is returned to the dry pan on the ground floor.

Storage Bin

The finished storage bin is constructed of 2- by 12-inch lumber placed on end. It measures 19 feet 2 inches in length, 13 feet 5 inches in width, and 16 feet in height, and its capacity is 250 tons of ground clay. It extends from a point beneath the screen on the third floor to the second floor of the building. Two simple, wooden, vertical chutes, 18 by 24 inches, having vertical slide gates of metal, discharge the ground clay into the wet pans below for the tempering process.

Miscellaneous

A main-line shaft 4-15/16 inches in diameter is driven by a large synchronous motor situated in a corner of the mill building on the ground floor. From this shaft are driven the dry pan and its plate feeder, the dry-pan elevator, the two wet pans, a wet-pan elevator, and the press feeders.

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This motor is 214-horsepower, 2,200-volt, 56.8-ampere, 3-phase, 60-cycle and travels at a speed of 900 r.p.m. Through a leather belt 22 inches by 32 feet 4 inches, it drives the above described main-line shaft at a speed of 275 r.p.m.

On the second floor is the motor-generator set that produces direct current for the electric vibrating screen. This is a direct-connected unit traveling at 870 r.p.m. A 2-horsepower, 220-volt, 6.4-ampere, 3-phase, 60-cycle motor drives a generator of 1.1-kv.-a., .45-kw., 115-volt, 10-ampere capacity.

Screen Analysis - Weight Per cubic Foot

A sample taken from the finished clay-storage bin by the author gives the following results as determined by the United States Bureau of Mines laboratory at Pittsburgh, Pa.:

Screen analysis

	Screen size, mesh	14	20	28	35	48	65	100	150	200	Minus 200
Sample No. 1.	Percent	3.0	15.4	15.8	11.2	13.0	7.9	7.9	4.3	4.6	16.9
	Cumulative	3.0	18.4	34.2	45.4	58.4	66.3	74.2	78.5	83.1	100.0

Specific gravity. - Weight per cubic foot

	Specific gravity	Weight, lbs. per cubic foot
Sample no. 1	2.643	165.2

Miscellaneous

Figure 9 is a flow sheet listing all the operations just described above.

Power

All power is purchased from the Ohio Power Co. on a sliding-scale basis. It usually runs about $0.022 per kw.-hr. when the plant is operating at capacity.

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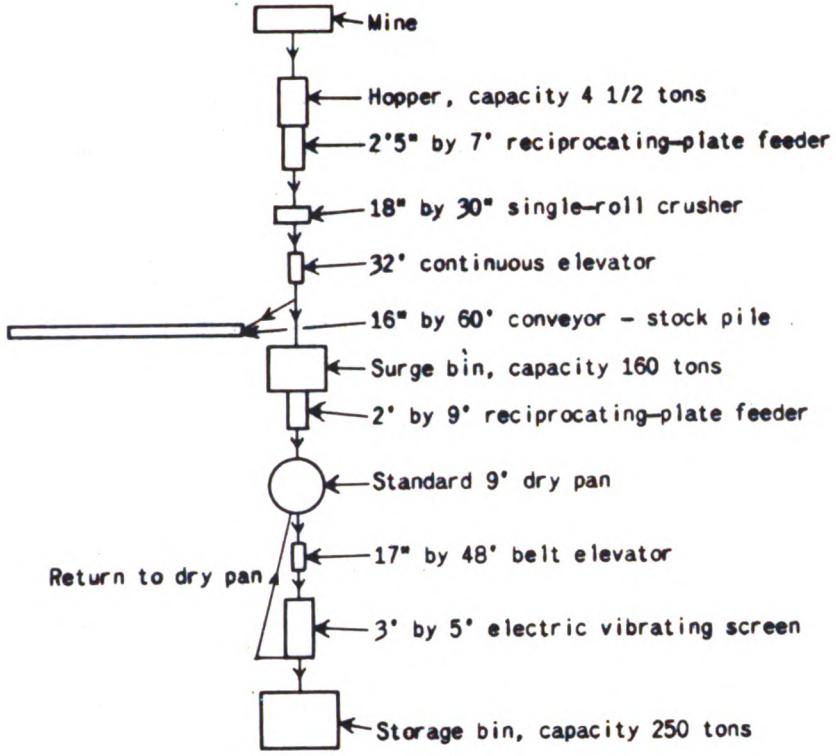
Mine
Hopper, capacity 4 1/2 tons
2'5" by 7' reciprocating-plate feeder
18" by 30" single-roll crusher
32' continuous elevator
16" by 60' conveyor - stock pile
Surge bin, capacity 160 tons
2' by 9' reciprocating-plate feeder
Standard 9' dry pan
17" by 48' belt elevator
Return to dry pan
3' by 5' electric vibrating screen
Storage bin, capacity 250 tons

Figure 9.- Flow sheet.

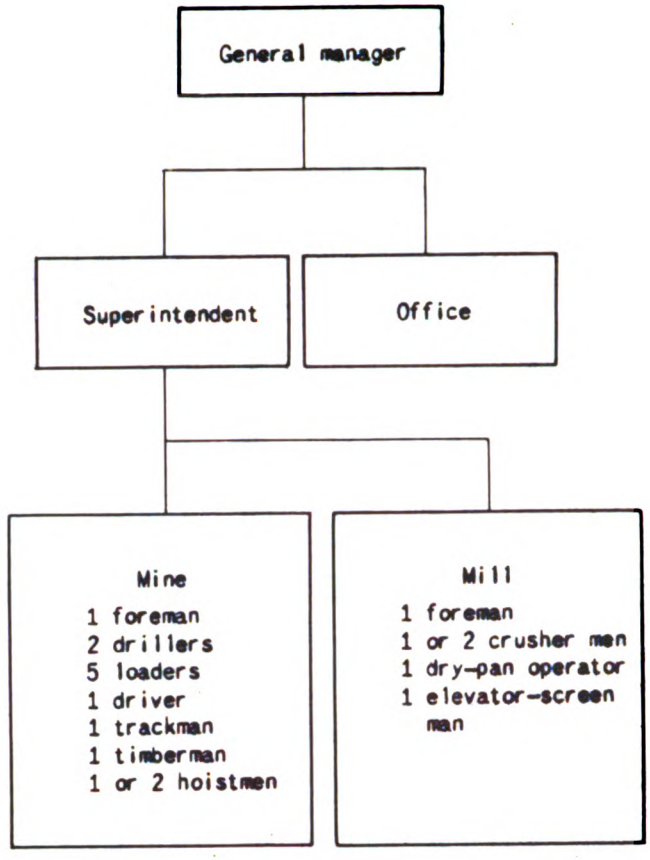

Figure 10.- Administration chart.

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PERCENT EXTRACTION

Initial mining yields a little over 20 percent recovery of the clay in the bed. When the pillars are drawn a recovery of approximately 90 percent is possible. The remaining 10 percent will be lost, due to contamination, roof falls, etc. This estimate is based on the assumption that all the pillars will be drawn at the proper time and also that the bulk of the sloughed clay will be recovered.

EMPLOYEE PAY SYSTEM

All loaders are paid on a tonnage basis. The remaining men all work on an hourly basis at rates that prevail throughout the district. The rates for an 8-hour day are as follows:

Labor classification	Number of men	Hourly rate	Hours per day
Drillers.....	2	$0.62	8
Loaders.....	5	1/ .26	8
Driver.....	1	.62	8
Timberman.....	1	.62	8
Trackman.....	1	.62	8
Hoist and crusher man.	1	.60	8
Dry-pan operator.....	1	.47	8
Elevator screen man...	1	.47	8
Repair man.....	1	.55	2
Mine foreman.....	1	Salary	-
Mill foreman.....	1	Salary	-

1/ Per ton.

SAFETY METHODS AND FIRST AID ORGANIZATION AND TRAINING

Employees are continually cautioned to exercise the utmost care at all times. First-aid materials are provided for minor cuts and injuries. Stretchers are available for the more serious accidents, the injured being taken to the town of Uhrichsville for treatment. No first-aid organization or training classes are held at the present time.

FORM OF ADMINISTRATIVE ORGANIZATION

Figure 10 is an organization chart showing the proper distribution of authority. The plant superintendent has full authority over both mine and mill, with a foreman in charge of each. The mine foreman, however, is generally charged with entire responsibility for the successful operation of his department. He usually obtains his instructions direct from the general manager. Each foreman has the authority to hire or discharge his own men as he may see fit.

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1. - Summary of costs

NAME: Clay City Pipe Co., Uhrichsville, Ohio PERIOD COVERED: 1935.

TOTAL TONS CLAY LOADED: 14,095.

Operating costs per ton clay mined

Classification	Labor	Super-vision	Air Drills Steel	Power cost	Fuel cost	Explo-sives	Other sup-plies	Total
Drilling and blasting....	$0.1219	.....	$0.0015	.....	....	$0.0616	$0.0011	$0.1861
Loading.....	.2605	.....	.....	.....	....	.....	.0018	.2623
Transportation	.1272	.....	.....	.....	....	.....	.0514	.1786
Timbering.....	.0566	.....	.....	.....	....	.....	.0500	.1066
Pumping.....	.....	.....	.....	$0.0286	....	.....	.0049	.0335
Hoisting.....	.0203	.....	.....	.0116	....	.....	.0138	.0457
Miscellaneous.	.....	$0.1036	.....	.0152	....	.....	.0030	.1218
Mining cost....	.5865	.1036	.0015	.0554	....	.0616	.1260	.9346
Crushing.....	.0210	.....	.....	.0383	....	.....	.0039	.0632
Grinding.....	.0454	.....	.....	.1200	....	.....	.0098	.1752
Screening.....	.0299	.....	.....	.0053	....	.....	.0018	.0370
Elevating.....	.0158	.....	.....	.0591	....	.....	.0011	.0760
Miscellaneous.	.....	.0085	.....	.....	....	.....	.0036	.0121
Prepara-tion cost..	.1121	.0085	.....	.2227	....	.....	.0202	.3635
Total.....	.6986	.1121	.0015	.2781	....	.0616	.1462	1.2981

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2. - Summary of costs in Units of Labor, Power and Supplies

NAME: Clay City Pipe Co., Uhrichsville, Ohio. PERIOD COVERED: 1935.

TOTAL TONS MINED: 14,095.

	Mining	Crushing	Other	Total
LABOR (man-hours per ton):				
Drilling and blasting	0.18	.....	.....	0.18
Loading	.46	.....	.....	.46
Hauling	.09	.....	.....	.09
Timbering	.09	.....	.....	.09
Pumping	....	.....	.....	....
Hoisting	.05	.....	.....	.05
Miscellaneous	.09	0.05	0.18	.32
Total labor	.96	.05	.18	1.19
Average tons per man per shift	8.30	88.00	25.10	6.70
Labor, percent of total cost				82.36
POWER SUPPLIES:				
Explosives (pound per ton)	.48	.....	.....	.48
Timber (linear foot per ton)	.67	.....	.....	.67
Total power (Kw.-hr. per ton):				
Drilling	....	.....	.....	.....
Locomotive	....	.....	.....	.....
Pumping	.77	.....	.....	.77
Hoisting	.02	.....	.....	.02
Ventilation	.22	.....	.....	.22
Crushing	....	.85	.....	.85
Grinding	....	.....	2.75	2.75
Screening	....	.....	.12	.12
Elevating	....	.....	1.32	1.32
Conveying	....	.....	.....	.....
Other supplies in percent of total supplies	....	.....	.....	29.82
Supplies and power, percent of total cost	....	.....	.....	37.64

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3. - Detailed summary costs, direct-operation mine

NAME: Clay City Pipe Co., Uhrichsville, Ohio. PERIOD COVERED: 1935.

TOTAL TONS LOADED: 14,095.

Classification	Amount	Cost per ton	Total cost per ton
LOADING.....	$3,699.70	$0.2623	$0.2623
DRILLING:			
Operating labor.....	1,397.48	.0992	.....
Air, gas, power.....	.....	.....	.....
Operating supplies.....	22.00	.0015	.....
Repair labor.....	120.00	.0085	.....
Repair supplies.....	7.50	.0006	.....
Total drilling.....	1,546.98	.1098	.1098
BLASTING:			
Labor.....	199.64	.0142	.....
Explosives.....	869.03	.0616	.....
Other supplies.....	7.50	.0005	.....
Total blasting.....	1,076.17	.0763	.0763
HAULAGE:			
Locomotive.....	.....	.....	.....
Mules.....	1,199.56	.0850	.....
Cars.....	265.00	.0188	.....
Track maintenance.....	1,053.56	.0748	.....
Total haulage.....	2,518.12	.1786	.1786
TIMBERING:			
Labor.....	798.56	.0566	.....
Supplies.....	704.80	.0500	.....
Total timbering.....	1,503.36	.1066	.1066
GENERAL CHARGES.....	2,834.88	.2010	.2010
Grand total.....	13,179.21	.9346	.9346

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